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A Lecture on Water.*

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[Reported stenographically by S. J. Borrows, Esq.]

[Abstract by the Editor of this Journal.]

COMPOSITION OF WATER.

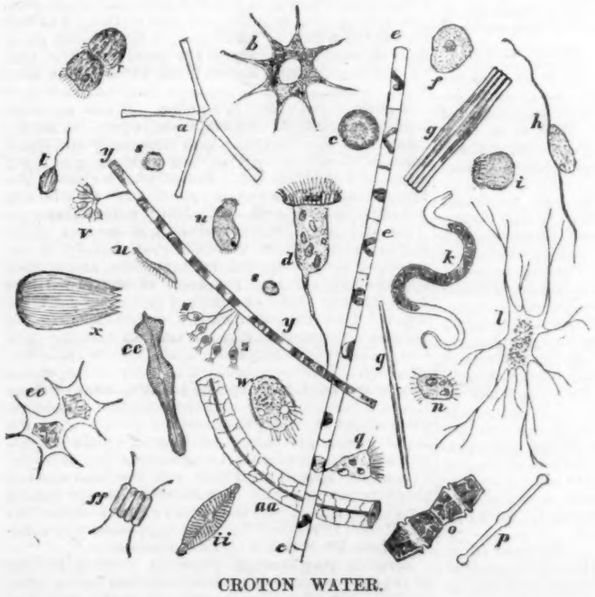
The Hindoos and the Egyptians considered water the elements from which all other bodies were formed. Among the Greeks the idea was maintained that water was the first or fontal element; that from it all other substances were produced; that even plants and animals owed their origin to it. Aristotle regarded water as one of four elements, and this idea was maintained for more than a thousand years, though the old idea that water was the primal element, seems to have been mingled with this idea, for it was supposed that these four elements, fire, earth, air and water were mutually convertible. Heat converted water into invisible air; repeated evaporation, they said, converted water into earth, so that there seems to have been an original idea, that water was the only real element.

Lavoisier, in 1770, tested experimentally the question of the conversion of water into earth. He distilled three pounds of water again and again, in an alembic provided with a condenser, and had a residue of twenty grains of earthy matter in the alembic. As the water had not diminished, he justly concluded that it had not come from the water; it must then have been derived from the alembic itself. On cleaning the alembic and condenser, and weighing them, it was found that they had lost 17 grains. Scheele, the great Swedish chemist, tested the same question, and not only proved that the earthy matter was derived from the glass, but analyzed it and found it to consist of the same constituents; potash, lime, and silica.

Oxygen was discovered in 1774 by Scheele and Priestley; but it was not till 1783 that Lavoisier, correctly interpreting the observations of Cavendish, proved water to be composed of oxygen and hydrogen; proved it to be a compound, instead of an element. He identified its constituents as the hydrogen long known and the oxygen which had been discovered a few years previous. Humboldt and Gay Lussac decided that water contained eight parts by weight of oxygen, and one part by weight of hydrogen. In 1772, nitrogen was discovered in the atmosphere; and in 1775, Lavoisier proved that the air was a mixture of oxygen and nitrogen. So it is just 100 years since the great fundamental discoveries were made upon which chemistry rests, and all the sciences, geology, mineralogy, physiology, etc., which are based upon it. Lavoisier, when he introduced the balance, made the first great step in advance, and in this way decided the fate of the old phlogiston theory, and many other theories which were based upon error.

The composition of water is beautifully shown by the decomposing action of the voltaic current. I have here a voltaic battery, the wires from which terminate in plates of platinum. In this glass jar is water, which has been colored pink to make it visible, and has been acidulated to make it a good conductor of electricity. Notice that the hydrogen from the negative pole occupies twice the volume of the oxygen from the positive pole, but the oxygen being sixteen times heavier than hydrogen, this small quantity of oxygen weighs eight times as much as double its volume of hydrogen. I can show you the properties of these two gases by a single experiment. Hydrogen is combustible. We have merely to cause it to escape by depressing this cylinder which contains it in a vessel of water, and to apply a flame to indicate this fact. Now you see that the hydrogen is burning with a blueish flame. Thus we have a combustible gas produced by the decomposition of water.

You have now seen that the voltaic current decomposes water, setting free its component gases; the combustible hydrogen, and the supporter of combustion, oxygen.



CROTON WATER.

RIDGEWOOD WATER.

OXYGEN.

Oxygen is the most abundant element in nature. Almost every other element on the earth's crust occurs combined with oxygen, and really the earth's crust is composed of the ashes produced by the combustion of the other elements. Still there is an excess of oxygen which we find in our atmosphere. You see the

* This lecture was prepared with special reference to the sanitary importance of pure water.

changed character of the flame of the taper when introduced into the gas.

Many substances have the power to decompose water by robbing it of its oxygen, setting the hydrogen free. This metal potassium which I now project upon the surface of the water in the jar, rapidly appropriates the oxygen of the water forming potassa which dissolves. The hydrogen escapess and you see the heat of the reaction has set it on fire and it burns with a beautiful violet flame. The color of the flame is due to a portion of the potassium which is vaporized. The water is thus actually set on fire by the potassium.

By placing a bit of this metal on the priming of a cannon, and applying an icicle we fire the piece, I will spare you the shock of the explosion, by omitting the experiment. But the principle will be as well shown when I apply this icicle to the wick of my spirit lamp, on which I have placed a bit of potassium. For, see, it lights at once. We have, therefore, set an icicle on fire, and lighted the lamp.

HYDROGEN.

In this jar we have the other constituent of water, hydrogen. As I hold the jar with its opening downward it will not readily escape, as it is the lightest substance known, being only one-fourteenth as heavy as air. Now, on bringing the burning taper near the mouth of the jar, you see the hydrogen burns where it is in contact with the air, while the taper is extinguished. As I withdraw the taper, it is relighted on passing through the flame of hydrogen.

This experiment illustrates the combustibility of the hydrogen, and its inability to support the combustion of the taper. The terms *combustible* and *supporter of combustion* are merely relative; in an atmosphere of hydrogen the oxygen would be combustible and the hydrogen the supporter, while the taper would be incombustible.

PROPERTIES OF WATER.

Water is the most important and the most remarkable of all our chemical compounds. It covers three-quarters of the earth's surface, in the form of ocean, lake and river, and in the higher latitudes snow, ice, glacier and iceberg. Rising in the form of vapor it produces by condensation clouds, fog, mist, rain and snow. In the vegetable kingdom it is ever present, varying in quantity from ninety-nine per cent. down to fifteen or twenty. Dry wood contains twenty per cent. of moisture. Animals consist largely of water. An average man weighing 150 pounds, contains about 116 pounds of water. The rocks contain it; some hold it in large quantity. Gypsum contains twenty per cent. of water, and even rocks, which are not hydrated compounds, contain it in moderate quantity, a fraction of a per cent. It is a bad *conductor* of heat, but has a great *capacity* for *heat*. A cubic mile of water in cooling one degree warms over 3000 cubic miles of air a like amount. And when water freezes it evolves a large amount of heat. A cubic yard of ice, in the process of melting, absorbs the heat which it gives out in freezing; it takes up enough heat to change the temperature of 21,000 cubic yards of air from 52 deg. to 32 deg. Fahr. On account of this great capacity for heat, this absorption of heat when ice melts and this evolution of heat, when it freezes, water becomes the great regulator of the temperature of the earth.

NATURAL WATERS.

Water being a great solvent, dissolves to some extent, whatever it comes into contact with. Even atmospheric waters, the rain and melted snow are not pure. Rain, as it falls through the air, washes out the solid particles of dust, and the germs of animals and plants. And in addition to these it dissolves the oxygen, the nitrogen, carbonic acid and ammonia of the atmosphere, a greater proportion of the oxygen than of the nitrogen. The air which is dissolved in water is much richer in oxygen than ordinary atmospheric air. This seems to be a special provision of nature for the fishes. They extract the small quantity of oxygen which is dissolved by the water from the air. The quantity is very small. Twenty-five cubic feet of water take up only one cubic foot of oxygen. But this quantity is sufficient for the maintenance of life in the fishes; their gills enable them to absorb it, and they die without it.

Water which is collected from roofs in the city is never pure. It contains gases which are only developed in cities, sulphur compounds, products of the combustion of coal. After thunder storms, the rain water is always found to contain minute quantities of nitric acid produced by the electric sparks which cause the oxygen and nitrogen of the air to unite. Rain water almost always contains a little organic matter, causing it to become putrid when kept for some time.

SPRING WATERS.

Terrestrial waters are always impure, Rain falling upon the earth's surface is absorbed by the porous soil, and the materials of which the soil is composed, being to a greater or less extent soluble, the water becomes contaminated with mineral matter. The character of spring water, therefore, depends upon the character of the soil through which it has passed before it issues as a spring. In New England, where the rocks are granitic, and the minerals, chiefly quartz, feldspar and mica, water is extremely pure. But in limestone countries where carbonate of lime and magnesia abound, we find the spring waters largely contaminated with these substances. These carbonates are rendered much more soluble in water by the carbonic acid present, which forms bicarbonate with them.

In this jar is some lime water; a clear solution of lime. The carbonic acid water, which I now add from the syphon bottle, produces carbonate of lime, which makes the liquid milky; but you see it now disappears on the further addition of carbonic acid. The clear liquid now contains the bicarbonate of lime. To such solutions of bicarbonate of lime are due many curious phenomena in nature. Where they trickle down from the roofs of caves, the evaporation of a portion of the carbonic acid causes the separation of an equivalent quantity of carbonate of lime. Each drop, as it hangs for a moment and then falls, leaves behind a thin pelicle of solid spar, and finally, in years of dripping, a stalactite is formed. Where the drops strike the floor of the cave, corresponding stalagmites gradually spring up, often meeting the stalactites at last, and forming columns of glistening stone. Sometimes where the water falls from a crevice, a series or row of columns is produced, which finally becomes a solid wall or partition of calcareous spar.

On boiling solutions of bicarbonate of lime and magnesia, the excess of carbonic acid is expelled, and the carbonates having no longer a solvent are precipitated. In this way incrustations are formed in tea-kettles and steam boilers.

Spring water is generally very clear, although it may be quite impure. It holds its impurities in solution. The soil through which it has passed, although it has conferred upon it its impurities, has at the same time filtered it, and thus rendered it clear and sparkling. As it comes from below the surface, it is generally cool. For these reasons spring water has always been highly prized. Wells which are dug down below the surface, are supplied partly by springs and partly by local drainage. The water may be very pure, or, if the surrounding soil is calcareous or charged with the refuse animal matter of neighboring dwellings, it will be very seriously contaminated with impurities.

NATURE OF THE IMPURITIES OF SPRING WATER.

Ordinary spring waters (fresh waters, as they are generally called) contain salts of the alkalies and alkaline earths: Chlorides, sulphates, and bicarbonates of potassa, soda, lime and magnesia. The most common salts are the chlorides of potassium and sodium, the sulphates of soda and lime, and the bicarbonates of lime and magnesia.

Besides these alkaline and earthy salts, we almost invariably find silica, the substance of quartz, to the amount of a grain or less in a gallon. In wells which receive drainage waters, in the neighborhood of dwellings, we generally find nitrates, nitrites and ammonia salts, derived from decomposing animal matter in the soil.

I have here a sample of impure well water, in which you shall see some of the more common impurities. Carbonic acid is shown in this jar by the addition of lime-water, which forms carbonate of lime, visible to you now as a milky precipitate. Lime is apparent to you as a white precipitate, produced by the oxalate of ammonia, which I am now adding to the second jar of the water. Sulphates are shown by the white precipitate which will appear on the addition of hydrochloric acid and chloride of barium to this third jar. You see it forming now. Chlorides, common salt, etc., are now apparent in this jar, to which I have just added nitric acid and nitrate of silver.

There is a popular idea, originated by some itinerant temperance lecturer who pretended to analyze liquors, that chemical analyses are made with the aid of a machine, into which the liquor to be analyzed is poured, and from which on turning a crank the constituents flow successively. The lecturer referred to, employed such a machine in analyzing wines and liquors to terrify his audience, showing the logwood, fusel oil, strychnine, etc., which he supposed to be used in compounding them. You see, however, that reagents are employed to detect and separate the different constituents of the water. No machine will answer the purpose.

HARD AND SOFT WATERS.

Lime salts in water are the cause of what is called *hardness*. They decompose the soap used in washing, forming a flocculent insoluble compound, and destroying its detergent properties. In Glasgow the saving to the people in soap, due to the introduction of the pure water of Loch Katrine, in place of the hard well waters previously used, is said to amount to $180,000 per annum.

You see before me two tall jars of water. One water is pure and soft; the other contains much lime and is hard. I will add to each a solution of soap in alcohol. You see now that on shaking this jar a fine froth or soap suds is produced. This is the soft water. Now I will shake the other jar, and you see we get no suds; but the liquid becomes white and milky. The lime has destroyed the soap. Soap is, therefore, an excellent reagent for testing water; a fact which is well known, though but few persons understand that it indicates the lime compounds only.

As bicarbonate of lime is destroyed by boiling, with the formation of insoluble carbonate of lime, which does not act on soap, it is said to produce *temporary hardness*, while sulphate of lime, which is not affected by boiling, produces permanent hardness.

ORGANIC MATTER.

Another impurity which is always present in water, but whose exact chemical character has not been fully determined, is organic matter. This is undoubtedly a collective term for a great many different substances derived from decomposing vegetable and animal matters. I will show you a test which is often used for the detection of organic matter. It is the permanganate of potassa. You notice the beautiful pink color which is produced as I add a few drops of this reagent to this jar of water. But you see the color gradually fades away. This is because the organic matter takes oxygen from the permanganate, destroying it, and undergoing oxidation itself. The quantity of permanganate the water is capable of bleaching is a rough index of the proportion of organic matter present. A little time is required for the organic matter to bleach the permanganate; the sample of water before you received an addition of organic matter for the occasion, that you might not be obliged to wait long to see the color disappear. As the permanganate destroys the organic matter it is often used to purify impure waters, organic matters being the most objectionable impurities which occur in natural waters.

POND, LAKE AND RIVER WATERS.

Pond, lake and river waters are generally purer than spring water, for the reason that while those bodies of water receive the waters of springs, they also receive a considerable quantity of water which has simply run *over* the surface of the earth. When a shower comes up, a portion of the water goes through the soil and issues as a spring; but a large portion of it runs over the soil, and goes into the lakes and rivers without taking with it much mineral matter. For this reason the waters of lakes and ponds are much purer than those of the springs in the same locality. One of the purest waters known is the water of the river Loka, in Sweden, which contains only one-twentieth of a grain of impurities in a gallon. Rivers are more likely to be charged with *suspended impurities*, for the reason that their waters, which have not been filtered through the soil, carry with them a certain quantity of mud and organic matter. That is what we see in Potomac water; it has had no opportunity to settle, and has not been filtered out. When water flows into lakes and the sediment subsides, it becomes clear. But in streams where the water runs rapidly, it has no opportunity to deposit its sediments, and it often appears very turbid. The water of the Mississippi contains forty grains of mud per gallon; and it is estimated that this river carries 400,000,000 tons of sediment per annum into the Gulf of Mexico. The Ganges is said to carry down 6,368,000,000 cubic feet annually. This transportation of mud in suspension has produced large deposits at the mouths of these rivers. All of the State of Louisiana, and considerable portions of other States which border upon the lower Mississippi, have been formed by the deposition of these sediments brought from higher levels. This mud is rich in plant food, and the land which it produces is very fertile. The Mohawk flats are famous for their fertility; and the annual overflow of the Nile is the chief reliance of the poor Egyptians, who cultivate the fields enriched by its sediments.

Rivers flowing through populous districts, and receiving the drainage of the towns on their banks, often become contaminated with sewage to such a degree as to make them positively offensive, and dangerous to those who drink their water.

LIVING ORGANISMS IN WATER.

In addition to the soluble and suspended impurities already mentioned, we find living organisms in water, animals and plants. In the diagrams above presented you will see some of the most common forms of the Croton and Ridgewood waters.

I simply call your attention to one of these animals; this one lettered *e*, the amœba guttula. This is an animal which has no mouth, and yet contrives to put himself outside of his dinner by a very curious process. When a particle of food comes in his way, a little dimple is formed on his side, it does not matter which side. He thus very readily extemporises a stomach for his food. The soluble portion is absorbed, the insoluble portion is ejected, and the animal assumes his rotundity, and goes on his way rejoicing. These animals, when magnified by the microscope are very frightful in their appearance and motions, but they are not really objectionable. The plants even

exercise a purifying influence on the water. It is stated by a celebrated English author, that the providential spread of the American weed Anacharis Alcinastrum, has saved thousands of lives by the purifying influence which it has exerted on the water courses in certain districts in England. These plants liberate oxygen which attacks poisonous dead organic matter and destroys it, thus ridding the water of its most dangerous impurities.

It occasionally happens however, owing perhaps to some peculiarity of the season, that microscopic animals or plants multiply to such an unusual extent in the waters of lakes or rivers, as to produce serious annoyance. This occurred some years ago in the Croton Lake. The subject was investigated by Dr. John Torrey, who reported the presence of myriads of animalcules which by their death and decomposition, communicated to the water a disagreeable taste and odor.

[To be continued.]

On the Removal of Impurities from Coal Gas.

By P. Innes, Gas Works, Forfar.

[Prize Essay read before the Meeting of the North British Association of Gas Managers.

[Concluded from page 23.]

Assuming that crude gas, when it gets the length of the purifiers, contains only 1 volume of ammonia, 8 of sulphuretted hydrogen, and 20 of carbonic acid in 1000 volumes of the gas, as Dr. Letheby says that it ought not to exceed that amount, this gives us 28 volumes of acid to 1 of alkali impurity; and, supposing that the alkaline impurity is totally absorbed—which never happens in any process—it still leaves over 27 parts of acid to be removed by the purifiers. It will thus be seen that the removal of acid impurity is prevented by the absence of sufficient alkali to neutralize it, and, we may add, of water to retain it; for, to carry any more alkali than what at present exists in gas to the purifiers, would just lead to a greater amount of it in purified gas. Washing the crude gas with gas liquor until it attains a certain strength, and introducing into the gas pure ammonia in solution, are means which are employed for removing part of this excess of acid, and at the same time to pick up ammonia also. The theory upon which this is based is self-evident when pure ammonia is used; but we are afraid that there is an error in supposing that common gas liquor can remove acid impurity by imparting to it ammonia for absorption. Ammoniacal liquor, as we get it, contains no free ammonia, as it all exists as sulphide, or carbonate principally, and, if there is any free impurity in it, it is acid, sulphuretted hydrogen or carbonic acid; its smell tells that plainly, and in general it is the former of these acids.

To introduce ammonia in the form of carbonate and sulphide, as in gas liquor, is useless in endeavoring to lessen the acids by chemical absorption, and as far as mechanical absorption is concerned, ordinary water is more potent in this respect, used in the same manner as the liquor, pumped over and over again until it reaches the desired strength. By repeated washings with gas liquor we may absorb acids by virtue of their solubility in water, and we may search out some more of the salt vapors of ammonia by the same means; but this is mechanical absorption, not chemical, and the strong liquor thus obtained will contain excess of acid generally, sulphuretted hydrogen being more soluble than carbonic acid. Pure caustic ammonia introduced into crude gas in a gaseous or finely divided aqueous state ought to be most effective in removing sulphuretted hydrogen and carbonic acid, as theoretically two volumes of the alkali will absorb one volume of sulphuretted hydrogen or carbonic acid in producing the vaporous salts of these acids, so that 54 volumes should remove all the aforementioned amount of acid impurity, or 560 cubic feet of pure ammonia gas ought to remove all the impurity of a ton of coal which reaches the purifiers, without lime or oxide. The practical working out of this idea has not been very successful, we believe, and we attribute it as much as anything else to the process by which ammonia, or what goes under the name, is made. In most of these it is by heating gas liquor with the intention of driving off sulphuretted hydrogen and carbonic acid, and leaving ammonia. We maintain that pure ammonia, or a liquor containing any amount of free ammonia worth consideration, can never be made in this way. We mentioned before, when speaking of ammonia, that the salts of those acids contained in crude gas all volatilize in an undecomposed state; hence, when gas liquor is heated, the excess of sulphuretted hydrogen is first driven off, and what in the liquor is combined with ammonia, in being expelled by the heat, carries its ammonia with it, and the same applies to carbonic acid. So that in attempting to purify gas liquor by heat, we only lose ammonia with the acids driven off; The same objections hold in trying to purify gas liquor by filtering through lime. The only way is to distil the vapors through lime in the same manner as in the manufacture of caustic ammonia. Again, we think the manner of producing or effecting the absorption of acid impurity by a solution of pure ammonia distributed in the form of a shower gives insufficient intimacy of alkali with acid to obtain the desired effect in the best manner, and we may be excused if again we bring forward steam in which caustic ammonia is volatilized, as a medium calculated to permeate the gas in a manner most suitable for the extraction of sulphuretted hydrogen and carbonic acid, where such is desired to avoid or diminish the nuisance of spent lime or foul oxide. It may be objected to the use of steam in this form, that strong alkali is hurtful to hydrocarbons in the same way as strong acids are, and that the bisulphide of carbon would lose the decomposing influence of the sulphide of ammonium in the scrubbing process. To the first objection it may be said that the alkali, we presume, can be volatilized to any degree of strength, and that strong ammoniacal liquor is hurtful to the illuminating vapors of coal gas as well as pure alkali; to the latter, a comparison of testings for sulphur in the gas of companies who wash and scrub their gas and of those who do not, leads us to believe that very little of that reaction takes place in the process of scrubbing, at least in the case of cannel gas. The quantity of the bisulphide of carbon in gas is so small—supposing the 20 grains in the 100 cubic feet were wholly composed of that substance, it would only be equal to one-sixtieth part of a cubic foot of the vapor—that we do not wonder it escapes absorption by the imperfect contact of the liquor with the gas when presented to the gas in a shower. In the analysis of the gas of one company, where purification is conducted only by condensation and lime, we find the same amount of sulphur impurity as in the gas of a works in the same city where washing or scrubbing is effected, and this is generally constant.

Of the mechanical arrangements for regulating the supply of liquor in scrubbing gas, our space will not allow us to say anything further than that their construction should be so as to deliver it in a manner as near as possible to that exhibited in the natural process of condensation. Thus we have not a great body of water operating. Quite the reverse. When we consider the low temperature at which the water in the hydraulic is, rarely exceeding 120° Fahr., and that, as already mentioned, all the water produced in the distillation of the coal is there condensed, with the exception of what little the gas can retain at that temperature, and further, that this water is usually separated from the gas at this end of the hydraulic, it will be seen that the actual amount of water which proceeds with the gas is extremely small, but it has this advantage, that, being in the form of steam or vapor, the gas is completely intersected with it, and consequently the water gets impregnated with impurity to a greater extent than any artificial process as yet has effected. What we need is a *series* of natural condensations produced by an intermittent supply of water in a state of fine vapor.

The third method of absorbing ammonia consists in passing the crude gas through a very dilute solution of an acid, such as sulphuric acid, or between the interstices of some porous material, such as sawdust, saturated with the dilute acid. The gas passing through the solution leaves the ammonia in it, becoming an impure solution of sulphate of ammonia, the supply of acid being regulated so as to cause the acid to reach a certain specific gravity or saturation before removal for utilization. When passed through acidulated saw dust—the more practicable of the two methods—the sulphate is washed out and utilized as formerly. Objections have been raised to this method of removing ammonia, first, because it is corrosive in its action on the apparatus, an objection which can scarcely be applied to such diluted solutions as are actually necessary for absorption; second, that fumes of the acid are likely to get into the purified gas and exert their influence on the fittings of meters, etc., an objection which has less foundation than the first, when it is considered that the gas has subsequently to pass through lime with which it would form sulphate of lime, one of the many absorbents which have been used in connexion with the fourth method of removing ammonia—viz., by means of a metallic salt in solution, or in the dry state, sulphuretted hydrogen being absorbed simultaneously. This class of absorbents are numerous; indeed, almost any salt not containing the acid impurities may be used in the removal of ammonia with sulphuretted hydrogen. We can here only enumerate some of those which have been tried—viz., sulphate of lime, formed by sprinkling the first tray of lime with dilute sulphuric acid, or the same agent as gypsum. Sulphate of iron or ferrous sulphate, formed by treating oxide of iron with sulphuric acid, or the same substance in a crude state termed copperas, and a mixture of the sulphates of iron and lime (Laming's mixture), chloride of lime (calcium), solutions of the chlorides of manganese, and sulphates of lead and manganese, etc., etc.

Some of these agents we believe are still used in the larger gas works of England and the Continent; none in Scotland. The absorption is by what is termed a double decomposition in most cases, the ammonia taking the acid of the salt agent, forming a corresponding salt of ammonia, while the sulphuretted hydrogen takes the metallic part of it, forming sulphides of the metals. With the lime salts, such as the sulphates of lime and the chloride of lime, the whole three impurities may be partly absorbed,

Having, with one or other of these methods, left the minimum of ammonia in the crude gas, and at the same time absorbed sulphur, we have briefly to consider the removal of sulphuretted hydrogen and carbonic acid in the purifiers. In the smaller gas works these are removed simultaneously by hydrated lime. In the larger works it is becoming the practice to remove the sulphur first by oxide of iron. and the carbonic acid subsequently by lime. Oxide of iron, or, properly speaking, the hydrated peroxide of iron, may be prepared artificially, but in many cases it is used for purification in its natural state, mixed up with some granular substance, such as sawdust, to give it porosity. In most of the rocks composing the crust of the earth this substance is met with in all proportions, from the old red sandstone from which it derives its characteristic color, containing 6 to 7 per cent., to the rich hematite iron ores of the north of England, containing 95 per cent. of the peroxide. As we generally observe it in gas works it has a brown clayey appearance, containing a medium proportion of peroxide. It is likewise obtained in a fine powder, and in this form it is suitable for mixing with sawdust. It is also to be had mixed with sawdust ready for use. Like lime, for the purpose of facilitating chemical action, it is moistened with water.

The mixing of oxide of iron with sawdust for the purpose of giving porosity reduces the amount of purifying material bulk for bulk, compared with lime, so much, that purifiers for using oxide require to have a greater area than lime purifiers, and if a natural ore is employed, having a small per centage of peroxide, the purifying ability of any given area will be considerably lessened from what it would be with an ore with a medium per centage, or the ore will require to be thicker in the trays the less peroxide it contains. Little or no smell arises from spent oxide until it is spread out for purpose of revivification. This process is effected by the iron taking oxygen from the air and again becoming oxide while the sulphur is set free. Of course all the sulphur is not liberated, as the air does not get into contact with the sulphide completely, lying as it does in mass; but the greater the space it covers the more of it will be converted again into oxide, and suitable for the absorption of more sulphur.

The sulphur now extracted, we have still 20 parts per 1000 of carbonic acid to remove, or about three-fourths of all the impurity which reached the purifiers; and, speaking roughly, three-fourths of the lime used, when it is employed to remove both sulphuretted hydrogen and carbonic acid, will still be required to extract the latter impurity. This is more satisfactorily done when the impurities are removed *seriatim* than when lime alone is used for removal of all the impurities, for although the other impurities are small in quantity compared with carbonic acid, yet the manner in which the lime gets clogged up with ammonia and tarry matter results in the loss of a portion rendered unfit for purification.

The extraction of carbonic acid alone is attended with no smell, the carbonate produced being inodorous, and to those accustomed to the by no means mellifluous fumes of a small gas-work, it is refreshing to stand over a foul carbonic acid purifier when opened for the removal of lime. Not only has it no smell, but, as we have seen, it is colorless, something like chalk when compared with the browner clean lime close by.

Where no sanitary restrictions are laid upon a gas company, lime is the best absorbent of acid impurity that can be employed. From its half alkaline, half earthy nature it has no chemical action upon the illuminating vapors and gases. Compared with oxide of iron, it will remove sulphuretted hydrogen and carbonic acid in less area than the oxide will remove the former of these alone, and for these and some other reasons we should prefer the use of lime alone, even in pretty large works.

But to obtain purification by lime in the most economical manner certain conditions must be fulfilled, a few of which we may notice. The crude gas ought to be well stripped of its tarry matter before entering the lime, either by washing or by good condensation, which may be furthered by having the purifiers a distance from the condensing apparatus, or by giving the gas a circuitous route to them. When the tarry matter collects on the outer surface of the lime, it cakes or hardens, the pressure on the retorts increases, and if the purifier is not opened and the lime broken up or renewed, the lute water will soon be blown out of the purifier with escape of gas, by the resistance of

the lime, and of the gas being unable to penetrate it. This is a matter of constant experience, especially in winter time, with imperfect condensing apparatus, and requires watchfulness on the part of the men in attendance. During the time of greatest manufacture, it is a practice when one purifier has been renewed that the other be opened and the hardened lime broken up, which is easily effected when the gas passes down through the lime—the better mode in small works for this very reason—but when the reverse is the case, with other annoyances, it leads to a loss of lime in partly replacing foul lime with fresh, although not indicating foul gas on testing.

The lime ought to be in a granular or mealy state, if it be too fine it will cake with its own weight and the water with which it is saturated, and become impervious to the gas, which seeks a passage elsewhere. If, on the other hand, the lime be lumpy, it results in a loss of it from the same reason; because the impurities cannot penetrate beyond the surface, and, consequently, the solid interior does no work. A ton of lime working under either of these extremes will, of course, purify less gas than in the medium state, and it shows the necessity of having a person specially set apart and instructed for the purifying department even in the lesser works. The lime ought to be well moistened, and that operation only done shortly before required, or at the time of renewing that in the purifier. Limestone is a carbonate of lime. When burned in kilns the carbonic acid is driven off, leaving it in the form of oxide of calcium, or quick or caustic lime, and in this state we get it from the lime-burner. Exposed to the air, it absorbs moisture from it, becoming hydrate of lime. In practice the same thing is effected by pouring water over it. The chemical absorption of the water by the lime in producing hydrate generates considerable heat, and causes it to crumble into pieces, occupying about twice its former bulk. In this state, termed hot lime, it is unfit for purifying gas. It requires to be further saturated with water, when it will greedily absorb carbonic acid. Lime water, which is a solution of the hydrate in water, soon becomes useless as a reagent to the chemist if left exposed to the air, owing to its absorption of carbonic acid. The dry hydrate does the same, but when further moistened it very soon becomes coated with carbonate of lime from the same cause, and hence the importance of not saturating the hot lime any considerable length of time before being required, or otherwise a quantity of useless lime, coated with the very impurity we wish to take from the gas, will be put into the purifiers to no purpose. When this does take place it may be mitigated by beating and breaking up the lumps, and repeatedly turning it over and over in order to expose fresh surfaces to the crude gas. It is a very good plan practised in some works to moisten the hot lime moderately, which preserves it in a granular condition better, and, when placed in a thin layer first, then watered, another layer of lime, and another watering until the desired thickness of lime is attained; bnt the time occupied in this would require a purifier always out of action. It is also a good plan not to slake the shells themselves too early.

Time is an important element in purification, in order to effect chemical action completely; or what comes to the same thing, the area of purifying material necessarily depends upon the volume of gas passing through it. A certain volume of gas, slowly permeating any given depth and area of lime or other purifying agent, will be deprived of its impurity at less expense of it, than when double the volume of gas is passing through the same area and depth of material. A case is before us. The same amount of lime which in winter purified on an average 80,000 cubic feet in one day, is at the present purifying over 120,000 cubic feet in seven days. In the former case the gas passed through the lime at the average of nearly 2000 cubic feet per hour, the purification being effected in winter in two sets of purifiers, while at present it is only at the rate of about 800 cubic feet per hour; so that to obtain the same work from the lime in winter as at present, the purifiers would require to have their area more than doubled with the same amount of lime spread over the increased area. In the latter case the gas or its impurities have time to linger over and search through the lime, causing a greater absorption by it; in the former, while part would be absorbed in the first tray, other portions would be swept right through altogether on to the second, which would be purifying simultaneously with the first, and the same incomplete action of each tray of lime carried forward to the last tray, as a consequence resulted in the indication of foul gas earlier than at present. Where plenty of purifying area is to be had, the lime ought to be thinly spread on the trays, and a sufficient space should intervene between the lime and the upper tray in order to (if we may use the expression) allow the gas to readjust itself before entering the lime again. When the lime is thickly spread on, as in some cases it is compulsory to do so where defective purifying apparatus occurs, the interior of the lime becomes a perfect hotbed by the heat which is generated in the combination of the impurities with the lime. The water it was saturated with is converted into vapor, which the rapidly passing gas carries with it, and thus the lime loses its absorbent power, for without water it is almost useless. The heat generated in the interior of lime in such cases is considerable, and from repeated trials we have found it to reach to 100° Fah., a temperature which is almost that of the gases on leaving the hydraulic. Indeed, we have found such as low as 95° Fahr., being less than that of the lime in the purifiers.

It does not take place so much in lime thinly spread, owing to the heat being better diffused in the space above and below, and for other reasons. Better, if possible, to have a greater number of trays of lime thinly spread than a few with the same, 5 or 6 or more inches deep. When no suitable intervening space is left between the lime and the upper trays, the gas is apt to proceed in straight lines from the perforations in the trays, thus forming holes in which the lime being soon fouled, the gas which follows will derive no absorption of impurity, the object being to get the gas to disseminate itself in all directions through the lime, which it cannot do if not allowed some freedom in emerging from each tray of lime.

Except in the smallest works, not less than three purifiers should be in one set, and renewed with lime when the second is fouled. This is far from being the case, however, many not having more than two in the set, the consequence of which is that while the one is being recharged with lime, the other is passing foul gas into the holder, unless the change should be made when the first purifier is fouled; but as in that case the lime is far from being thoroughly utilized, it would lead to a great expenditure of lime, which small gas companies cannot afford, or are unwilling to incur the expense of.

The condensation of the water vapor which collects in the connexions underneath the purifiers ought to be regularly drained off, and more so in winter, as it is saturated with sulphuretted hydrogen, and the purified gas is apt to absorb some of its vapor emanating from the water.

Accuracy of Dry Meters.

[Concluded from page 19.]

Examination of Mr. Hernany continued.

Here the witness demonstrated the various pressures, the control of the same, and at different periods, in offices, passages, or private houses, by applying different weights upon the prover, which had been filled with gas, and by the use of the stop-cock at the burner, and stated that the flow of gas was exclusively within the control of the consumer. He turned on the gas under a weight of 65-100 of an inch of water pressure, and again of over two inches of water pressure, under both conditions showing that for the purpose of producing a uniform or any desired condition of the flame at the burner, the same could be obtained by the use of the shut-off at the burner, by the consumer, at his pleasure. He proceeded:

The gas company cannot compel the customer to use more gas than he desires. The gas company may do as it pleases, the flow of gas is still under the control of the consumer. It is illustrated by the burners in halls and theaters. If they wish to turn down the gas they do not go to every burner and turn it down, but they go to the main stop-cock and turn that down; if they want more light they let it on. There can be no advantage to the gas company in their increasing the pressure beyond that which will give sufficient light in the districts through which their pipes extend, because whenever they increase the pressure to a greater extent than is necessary to furnish a good light through those districts, they increase the liability to waste by means of the almost innumerable joints in the pipes. My recollection is that the Louisville Gas Company have upwards of ninety miles of pipes. I should suppose there would be a joint to every eight feet of pipe, making nearly 700 joints to the mile, and about 6,300 joints in the distribution pipe alone, to say nothing about the numerous joints in the connecting pipes, all of which are liable to be to some extent imperfect, and cause leakage and loss of gas. Those leakages are outside of the gas meters, and as a matter of course do not affect the consumers. In addition to that, there is gas escaping through the very pores of the cast iron pipe, and so great is the loss of gas that it has, upon unquestionable authority, been estimated in the best managed works, to approximate 18 per cent. of the entire quantity that is sent from the main station. For this reason, it is an object with the gas company to distribute the gas at the lowest possible pressure that will answer the necessities.

There is seldom complaint made that there is too great a pressure, but complaints are numerous that the pressure is insufficient. If the pressure is low the consumer cannot get the quantity of gas desired. (Here witness gives an illustration with the meter under his hand.) They have at all the best gas works an automatic regulator, which governs the pressure of the gas flowing from the great main into the distributing pipes. When the mains extend over so large a territory that it produces fluctuations, and the pressure is so great as to incapacitate the automatic regulator from working, they put a man at the main, or several men where they have more than one main, who control by hand the main gate which admits the gas into the distributing pipes, precisely in the same manner as a pilot on our western rivers has his hand upon the wheel and his eye upon the landmarks. The man at the main gate keeps the gas at a uniform pressure. This is not done by the Louisville Gas Company, but it is done by some of the gas companies in the East.

Question by Mr. Bijur—Did you hear the evidence of Colonel Harney on Wednesday as regards his method of measuring the consumption of gas?

Answer—Yes, sir.

Question—I will ask you, as a scientific man, to state whether the capacity of a meter and the consumption of gas can possibly be calculated by linear measurement of the meter itself?

Answer—To that question I answer no—not as correct as is necessary for ordinary legitimate business transactions.

Question—Why?

Answer—Who can tell that these plates (on the diaphragm) were not bent in tearing the meter apart? For that reason I would not attempt to measure it. Another reason is, suppose it was in perfect working order, here is a plated diaphragm which is armored and riveted. It is not a quadrangular pyramid. It cannot be. Here are rivet-heads and corrugations and plates, which change the surface in every 1-16th of an inch that the diaphragm travels. It is not possible for me to measure them; for an absolute correct measurement all these things would have to be measured. I defy any mathematician or engineer to do it with such a degree of accuracy as is desirable in such matters. But if all these difficulties were removed, I would still object to this measurement for this simple reason; his measurement is simply the travel from the apex of one pyramid back to the other and the base. There are three measurements, the width, breadth and depth. These are the only measurements which can be made. I find by calculation that the cubic contents (of the space described by a vibration of the diaphragm) should be equal to 27.692 cubic inches; instead of that, Col. Harney, by his calculation, makes it 25.215 cubic inches; that is in error 2,477 cubic inches. His unit of measurement for the purpose of ascertaining the accuracy of this meter is a body that approximates a cube of five inches in dimensions, equal to about 1-70th of a cubic foot, which is the recognized standard unit for measuring gas. In the measurement of that body he has found that the meter is in error 2.477 of a cubic inch, or else he has made an error in his measurement to that extent. I would not attempt to measure it any nearer. I would not say that he made an error, or that this meter is in error, but he has made his measurement upon a cubical body that represents 1.70th part of a cubic foot, or the standard unit with which we start on. Now, then, if Col. Harney had measured a body equal in extent to that standard unit, and had made an error of two and a fraction cubic inches, it would not have been considered an error at all. In the measurement of this diaphragm, it has amounted to nine per cent. In a standard unit of dimensions (here he referred to the box representing the United States standard cubic foot), it would not have amounted to the 1-100th part of one per cent.

Now, instead of measuring meters with that unit, we take a body of gas equal to five times the standard unit, and consequently I say that the standard unit by which Col. Harney made his measurement was entirely too small to approximate to anything like that degree of accuracy which is desirable, and is required for the consumption of gas. To illustrate: The standard unit of liquid measure of the United States is a gallon of 231 cubic inches, a vessel with which you are all familiar. If Congress had made the standard of measure a capillary tube, that is, a tube which approximates the size of a pin, who could have measured it? The scope of human vision is not sufficiently extended, and microscopic instruments would be necessary. For that reason a vessel of reasonable dimensions, has been chosen; and in the measurement and distribution of gas, the standard foot is the unit. The water test to which the meter test has been subjected is still more unsatisfactory and for this reason: The meter (during this test) was held in the hands of Col. Mundy, I have no doubt as steadily and carefully as it was possible for him to hold it. One of its compartments was filled with water to a given height, and I could see that it approximated within half an inch of the top with the diaphragm extended to an extreme position. The elevation was estimated by the eye, if determined at all. There was no measurement made that I saw. It was poured into this cubical box (here showing Col. Harney's square tin box) and the depth measured and the contents calculated. That was the first process. After that the diaphragm was placed in

its other extreme position and again filled with water. I did not see how near the surface of the water rose to the top of the meter, but I suppose the aim was to make it as near the same height as before as possible. It was, however, guess-work, because there was no measurement. It was poured into this vessel (the square cup) again measured and the difference between the two measurements was declared to be due to the displacement in the diaphragm. The error found as stated before amounted to two cubic inches which would be equivalent to a depth of water in this cubical cup of about one-eighth of an inch, if the bottom of this vessel (cup) is equal to 16 cubic inches. [Here the witness showed the jury how much space would be occupied in the cup by two cubic inches of water, from a measure of known quantities, introduced by Prof. J. L. Smith.] You will perceive that this cup is not regular; that the bottom is curved, and that the sides are not perfectly straight. I have no doubt they meant to make it a correct measure, but the crude manner in which the thing is aimed at makes it worthless as a measure. I do not reflect upon the gentlemen who made the water test, but I do disapprove of the plan. I would not attempt it, and if I were compelled to make the attempt I would not claim to make it any better. Perhaps I could not make it as well or as accurate. As I stated before, I have no doubt it was their aim to make it correct. The capacity of the cup was taken at four inches. I find that, by the most careful measurement I can make here, it is 3-32 of an inch large. It is 4 inches and 3-32 of an inch large.

There is a liability to commit another error which would arise from capillary attraction.

Here he filled the cup with water, introducing his rule and showed that the water stood above a level around the rule. The witness continued:

An error made in calculations made upon the basis of a small unit like that taken by Mr. Harney, which is only one-seventieth of the standard unit of the gas company, would of course be much greater than could be made with the standard unit.

Here the large meter which had been used in the Opera House by the plaintiff from Sept. 9, 1870, was tested by the gas-prover of the defendant, in the presence of the jury. When the meter was filled and everything ready, the index hands stood at 2.2.7.7.12. The gas was turned on, and when the index hand of the prover showed that 10 cubic feet of gas had passed out of it, the index hands of the meter under test showed 2.2.7.7.22, or the use of 10 cubic feet and about 86 4-10 cubic inches of gas. The meter was pronounced fast to the very slight extent of 1 7-10 of 1 per cent.; and afterward, on examination of the attachment of the burner of the meter, the witness discovered a defect, which he said possibly might have caused the defect mentioned. He pronounced the meter correct within the limit made by usage and recognized by the contract between the city and the Gas Company, which is 3 per cent.

Illuminating Gas.

[The following selections are from an article in the *Am. Exchange and Review*, by Dr. C. Elton Buck, formerly Editor of this Journal.—Ed.]

Among the requirements of civilized life, there are few which assert themselves with more emphasis than some convenient form of artificial light. Whether we consider the subject in its moral, social, or economical relations, and from whatever standpoint we may view the question, the fact remains that light is one of the chief necessities of man, and in some form or other its artificial production has become more general and available in a direct ratio with the advance of knowledge and civilization. Among the applications of science to the arts, none have been more productive of useful results than those crude experiments in destructive distillation made by different investigators during the last century, which finally culminated in 1792 in the manufacture of illuminating gas. Whether regarded as a luxury or a necessity—for in both those aspects it presents its claims on our attention—its benefits have made themselves felt in all parts of the world; and wherever culture and refinement have their abode we find this form of artificial light an indispensable requirement. "It has extended the available term of man's life by giving the hours of the night to his use. It has, by the social intercourse it encourages, polished his manners and refined his tastes, and, perhaps as much as anything else, has aided in his intellectual progress."* Its influence in reducing the tendency to crime in towns and cities has been recognized. So accustomed have we become to its use, and so constantly do we rely upon it, both in domestic economy and in the demands of industry, that we are prone to accept its benefits simply as a matter of course, and to frequently overlook the importance of the art which furnishes us with so efficient a service.

[Some paragraphs upon the *early* history of Gas Illumination, chiefly already familiar to our readers, are omitted. The following historical matter, however, will be found of novel interest to many.]

In 1798 Murdoch erected gas works at Messrs. Boulton & Watt's Soho foundry, and having entered into the employment of that firm, he personally superintended the operation, and gradually perfected the details of the manufacture. That gas illumination, as illustrated by its employment at this factory, was a success cannot be doubted; and yet several years elapsed before it was generally adopted. In 1802, at the illumination in honor of the peace of Amiens, the superiority of the display produced by the Soho foundry was so marked that general attention was attracted to the new method of illumination, and its use gradually extended. A number of large cotton mills were lighted by gas about the year 1805. The Lyceum theatre of London was the first place of amusement which employed it, and in a short time, its advantages having become better appreciated, its use became more general. But notwithstanding the fact that these advantages obtained a wider recognition, some opposition was manifested to its introduction. Grave predictions of danger were uttered, and no little ridicule was cast upon the subject. When Napoleon was informed of the subject, he remarked: "*C'est une grande folie.*" Sir Walter Scott was no less incredulous, and said that he feared London would be set on fire by it from Hackney gate to Tyburn; while Lord Brougham declared that "the idea was worthy of the philosopher who proposed to extract sunbeams from cucumbers"—a remark, by the way, which, though uttered in a spirit of irony, in the light of modern scientific opinions contains elements of sober reality. Even Sir Humphrey Davy considered the idea of utilizing gas so ridiculous, that he contemptuously asked "if it were intended to take the dome of St. Paul's for a gasometer."

As soon as gaslight became firmly established in England, its merits claimed recognition on this side of the Atlantic, and in 1816 the first American gaslight company was chartered to light the city of Baltimore. Six years later, in 1822, Boston adopted the new method of illumination; while the old New York Gaslight Company, which lights the city from Grand street to the Battery, was chartered in 1823. Brooklyn and Bristol, R. I., were lighted in 1825. In 1830 the Manhattan Gaslight Company of New York, now the largest and wealthiest in America and fourth in size in the world, was chartered. The district of this corporation extends from Grand streeet to Thirty-fourth, and from river to river. Other cities pronounced in favor of the new light as follows: New Orleans in 1835, Philadelphia and Pittsburgh in 1836, Louisville in 1838, Cincinnati in 1841, Kensington (Philadelphia) in 1844, Albany in 1845. From this date gas works multiplied with rapidity, and as the superiority of the new light became evident, cities and towns in all parts of the country were soon supplied with it.

The Baltimore gas works were originally constructed to make gas from coal tar, but this plan proved a total failure, as might have been predicted. After this unsuccessful experiment, the works were reconstructed by an English engineer, but this change not proving satisfactory, they were again remodelled, and gas was made from bituminous coal. In Boston a mixture of coal and rosin was used, while in the two New York companies rosin alone was employed. All of these works were deemed more or less defective, and when, in January, 1833, the question of erecting gas works in Philadelphia was brought before the councils, a committee was appointed to consider the question and to make a report. In January, 1834, it was resolved to send an engineer to Europe for the purpose of investigating the best gas works there in operation, and to obtain such information as might be useful in erecting works in the city. The late Samuel V. Merrick was selected for this mission, and in furtherance of his instructions he sailed in March, returning in December of the same year. Notwithstanding a violent opposition to the project, gas works were erected by Mr. Merrick, and on the 10th of February, 1835, Philadelphia was first lighted with gas.

[Here we again omit the part relative to the mode of manufacture of gas.]

From the foregoing brief, and, in the absence of illustrations, necessarily imperfect description of the manufacture of gas, it will be seen that the process is comparatively a simple one, and yet there are questions continually presenting themselves in the routine of operations which demand no little scientific and practical knowledge; hence we generally find gas works placed under the supervision of persons of more than ordinary intelligence. In our large cities, gas engineers are generally selected on account of their scientific attainments, which include not only a reasonable acquaintance with the principles of chemistry, but more especially a knowledge of the physical properties of fluids, practical experience in the construction of buildings, furnaces, and the like, together with such other branches of information as are constantly required in the business. In England, and in all countries where large gas works abound, the profession of gas engineering includes among its votaries men of the highest culture and education; and the literature of this branch of technology has been enriched by contributions which are indispensable in every well-appointed scientific library.

Although more than seventy years have elapsed since coal gas was adopted as a source of artificial light yet the principal features of its manufacture maintain a remarkable conservatism; and, with a few exceptions, the changes which have taken place in the interval have partaken more of the nature of perfecting the apparatus employed than any real improvement in the process itself. This process, conspicuous alike for its simplicity and for the fact of its being the "realization of profound scientific research," is essentially the method introduced by Murdoch and perfected by Clegg and Berard; and although the labors of these eminent engineers have been somewhat supplemented by the experience of their successors, yet no radical improvement has been effected. The three steps into which the manufacture may be divided—carbonization, condensation, and purification—are virtually, in theory and practice, the same operations as were introduced by these pioneers of the profession. Perhaps one exception may be made to this assertion in the substitution of oxide of iron for lime in the purifiers. But when we take into consideration the fact that this change was made not for the purpose of improving the product, but chiefly, if not entirely, to obviate the foul odors arising from the spent lime, it can hardly be classed with inventions strictly intended to perfect the process of making gas. Purification by means of oxide of iron was patented in London in 1840, and since that time a number of modifications of the process have been perfected; but their adoption has been far from general. In London and a few other cities, gas companies have been compelled, for sanitary reasons, to resort to some form of oxide of iron purification. In New York the board of health recently insisted on the substitution of this process for lime purification, by the companies embraced within the metropolitan district.

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In Great Britain and Ireland, gas works are much more numerous than in this country. Almost every small village of a thousand inhabitants is lighted with gas. In 1860 the total number of companies in the United Kingdom was 1,015, distributed as follows: England and Wales 810, Scotland 141, Ireland 64. The aggregate capital at that time invested in the business was very nearly $100,000,000. The average price charged to private consumers was about $1.80 per thousand cubic feet, with discounts made to large consumers ranging from five to thirty per cent. Compared with the charges made by our American gas companies, this rate seems very low; but it must be remembered that labor, and consequently coal, iron, and all other essentials are far cheaper than on this side of the Atlantic.

In the whole territory of the United States there are not 500 gaslight companies.* The last accurate tables we have been enabled to obtain were compiled from official sources in 1863, and the number then returned was 433. At that time the price charged to consumers per thousand cubic feet, ranged from $1.50 at Pittsburg, to $12.50 at Marysville, California. In this country as in England, gas companies are usually private corporations, the exceptions to this rule being Philadelphia, Alexandria and Richmond, Va., and Frankfort, Ky., where the gas works are owned and operated by municipal authorities, or by trustees to whom their management is delegated. In considering the question whether it is more desirable for the consumer to be dependent on a municipal or a private corporation, opinions are divided; but experience has proved that if there is any difference in the practical results; it is not in favor of municipal management. In all cases the same rules of selling gas are observed; the same meters are used, and the same apparently arbitrary methods of treating delinquent consumers, or their successors, are followed. Gas companies are always made the target at which are aimed the shafts of indignant consumers; and no matter whether these are served by city works or by private corporations, the results are always the same. But whatever plan of dispensing illuminating gas may be pursued, the advantages of this over every other form of artificial illumination must be conceded. Its cleanliness, safety and economy are universally recognized; and were we compelled to undergo the deprivation of some of the essential comforts to which we have become accustomed, one of the last necessities we would voluntarily relinquish would be illuminating gas.

* Draper.

* We think this an understatement, but are not just now prepared to supersede it by any precise figures.—Ed.

Correspondence.

[Correspondents, in all cases, should sign their communications with their names and address in full—not necessarily for publication, but as a guarantee of good faith.—Ed.

Gas Affairs in Albany.

Albany, January 16, 1872.

Mr. Editor: In our capitol city there prevails just now a considerable agitation over alleged excessive charges for gas by the present company. Albany is a large city, accessible by rail and water communication to and from all points, at moderate rates, wherefore our citizens protest that $3.75 per thousand feet for an inferior article of gas is an overcharge, and the result of a monopoly which they do not feel disposed to tolerate. Accordingly "The People's Gas-Light Company" has been organized, and the projectors are meeting with unexpected encouragement on every side. Following close upon this is another organization, which has adopted the name of "The Illuminating Gas Company." Applications for leave to lay mains and pipes in all the public thoroughfares are now pending before the Common Council of the city.

The field is manifestly a legitimate one for competition, and must inevitably be occupied sooner or later. This can only be delayed by a degree of liberality on the part of the present company, such as will render the service in each accord with public sentiment alike in economy and quality. Albany is fair ground upon which to try the relative advantages of the old and the new methods of gas production, and the present agitation challenges the attention of the Gas Company of America, operating the Gale and Rand patents, the practical results of which as exhibited at Memphis and elsewhere, excite surprise and convey conviction to many who have hitherto been slow to yield up ideas based on the old and long-tried methods.

Yours, etc.,

Albanian.

A Large Pipe Foundry Burned.

The Union Pipe Foundry of Dennis Long & Co., Louisville, Kentuky, was destroyed by fire at 4 o'clock on the morning of 28lt ultimo. The pipe foundry was one of the most extensive in the United States, having a capacity for 27,000 tons of metal annually, the main building and wings covering nearly 150 by 210 feet, and was being run to its utmost capacity, having extensive contracts to fill. Nearly all the costly machinery was destroyed. The foundry was located where there was great difficulty in getting water. The fire engines had to be run to the river, and the hose had to be spliced in order to reach the burning building. There was considerable wind, blowing the sparks and burning brands towards a lumber yard, and a number of frame buildings east of the foundry, and that portion of the city was in great danger for a while. The foundry was supposed to be fireproof. The fire was the result of an accident, and was discovered by persons outside, the watchman in the building being asleep.

Gas Explosion in Indiana.—The City Gas Works at Richmond, Indiana, exploded at six o'clock on the night of January 23d. The engine house and purifying room are a total wreck. No lives lost. The accident was caused by changing the purifier—the gas escaping and catching fire from an adjoining room. Loss about $10,000.

A special despatch to the Cincinnatti *Gazette* says that the gasholders were not injured by the explosion of the Richmond (Ind.) Gas Works, and that the supply is but slightly diminished. There was but one man in the building at the time of the explosion, and he was seriously, though it is believed not fatally, injured. The purifying rooms were completely demolished, fragments being blown hundreds of yards.

New Style of Gas Meter.—Logansport, Ind., is to have a new style of gas meter, which registers the gas consumed in dollars and cents, instead of feet.

Chemical Repertory,

No. 63.—February 2, 1872.

EDITOR—HENRY WURTZ.

CHEMICAL EXCERPTS.

157. Velocity of Meteoric Stones.—In Prof. Nordenskjold's account of the Aerolitic Shower which took place near Hessle, in Sweden, on the 1st of January, 1869, he mentions as a remarkable fact, that stones weighing 2 lbs., which struck the ice of the Larsta-Viken, failed to penetrate, making holes only 3 or 4 inches deep in the ice and rebounding. (Vide the "Academy," Dec. 15, 1870.)

The small velocity retained by these stones, at the time of striking the earth is, doubtless, owing to the resistance of the air, and, consequently, is not an indication of the velocity which they had upon entering the atmosphere.—*Nature.*

[The interest of the above lies in the fact that many meteorites have been proved to pass into the atmosphere with a swiftness more than *ten thousand times* greater than that of the swiftest cannon-ball. The flame that attends their passage is believed to be due to heat produced by their compression of the air in front, as in the "fire-syringe." The writer has before suggested that if a cannon-ball *could* be projected with this velocity, it would burn up instantly as a streak of intensely brilliant flame. The probability is that the impulse necessary, however, to impart such a velocity to a cannon-ball would grind it to powder, in overcoming its inertia. We have also before thrown out the idea that aerolites which reach the earth are such as have had their velocity so reduced by friction that they become cooled below the vaporizing point before reaching the earth. The comparatively low velocities above recorded are thus easily understood. Much must depend on the angle at which they first strike the atmosphere. Some think that in mhteoric showers, they merely flame through the outer edge of the atmosphere, and shoot on in their appointed paths, like messengers from the outer universe who merely call to take a look at the earth in passing; but it may be, on the other hand, that these "falling stars" are altogether consumed or dissipated, reaching us only as impalpable dust.—Ed.]

158. Waterproofing Linen, Canvas, etc.—The following directions for waterproofing canvas and similar articles for tents, covers, etc., are given by H. Kuhr. The material is taken successively through a bath of sulphate of alumina, of soap and of water; it is then dried and smoothed or calendered. For the alumina bath, use the ordinary neutral sulphate of alumina of commerce (concentrated alum cake), dissolving one part in ten of water, which is done easily without the application of heat. The soap is best prepared in this manner: Boil one part of light rosin, one part of soda crystals, and ten of water, till the alum is dissolved; salt the soap out by the addition of one-third part of common salt; dissolve this soap with an equal amount of good palm oil soap in 30 parts of water. The soap-bath should be kept hot while the goods are passing through it. It is best to have three vats alongside of each other, and by a special arrangement to keep the goods down in the baths. Special care should be taken to have the fabric thoroughly soaked in the alumina bath.

In a note to the above, Drs. Hager and Jacobsen remark that during the last few years very good and cheap waterproof goods of this description have been manufactured in Berlin, which they believe is effected by steeping them first in a bath of sulphate of alumina and of copper, and then in one of water-glass and rosin soap.—*Jour. of Applied Chem.*

159. French Rivers.—M. Thome de Gamond proposes to suppress the natural profile of the large water courses which are imperfect, and to substitute for them a series of regular planes in successive slopes. This would be, in other terms, the transformation of the inclined planes of rivers into hydraulic staircases. The full regime would be maintained in those rivers where, in the natural state of things, the water is sometimes deficient, and sometimes in excess. For this purpose the overflow would be regulated by dams for the retention and distribution of the water, and there would descend to the sea only that portion which would be in excess after it had fulfilled all the numerous useful purposes for which it would be destined. Spacious reservoirs would also be established at the higher levels for storing up a portion of the superabundant rain water, to utilize it during dry seasons.—*Engineering.*

[The ingenuity of this "ingenious Frenchman" consists chiefly in applying other terms to what are familiarly known as "slack-water navigation" arrangements, which are so common, at least outside of France.—Ed.]

160. Xylonite.—Xylonite is a substance of which the chief ingredient is chemically allied to gun-cotton, formed by the action of nitric acid upon woody fibre. One of the chief uses to which it is applied is for making impermeable sheeting; and if all that is said about it bears the test of experience, it bids fair to take the place of india-rubber. Different samples of waterproof fabrics vary in substance from a thin transparent tissue up to a thick, strong cloth suitable for water-beds, water-cushions and other articles where strength of fabric is all important. Xylonite has several advantages over india-rubber. It is not affected by a boiling temperature, and can be readily washed in soap and water and ironed like ordinary linen or cotton fabrics. It is not acted upon by oil or grease. Xylonite materials can be made of any color, are considerably cheaper than similar gutta-percha or india-rubber fabrics, can be used again and again, and can be kept in store for any length of time without deterioration.—*London Lancet.*

[Is not "xylonite" merely the familiar castor-oil and collodion compound?—Ed.]

The Metropolitan Gas Company's Consumers.

Consumers of gas in the district bounded by Thirty-fifth and Seventy-ninth streets, and the East and North Rivers, will be glad to hear that a movement is making for their relief. Heretofore they have been dependent for their gas solely upon the Metropolitan Gas Company, whose works, located on the North River, at the foot of Forty-second street, are both too small and too remote to supply the whole district of which they claim a monopoly. A petition is in circulation requesting the Common Council to authorize the New York Gas Company, whose works are situated at the foot of Twenty-second street on the East River, to extend their pipes into the Metropolitan Company's present district. Should this petition be granted, the New York Company would at once furnish gas not only in more abundant quantity, but at a lower price than is now charged by the Metropolitan Company. At all events, the competition cannot but be of advantage to the public.—*N. Y. Sun.*

Improvement in Water Pipes.

We learn from the *Evening Post* that "a new kind of pipe has been devised for the conveyance of water. Hitherto no one could drink water that had long stood in common lead pipes, without danger of taking a poisonous oxide. The new pipes, it is thought, will carry the water as pure as when it first entered them. They are made with an outside of iron and an inside of glass, while between these two surfaces there is a cushion of plaster of Paris, which being a non-conductor, keeps the pipe cooler in summer and warmer in winter than the ordinary kinds. The smoothness of the glass also decreases the friction, so that water can be carried to a greater height with the same force; while the pipes cost less than lead pipe and less than half the price of tin-lined or block-tin pipe. This pipe, it is also said, can be used for the conveyance of gas, the glass preventing the loss which takes place through the pores of iron pipes, and of other liquids which it is desirable to keep pure. A company is now in process of organization for the manufacture and sale of these pipes, under the management of Messrs. E. H. Austin, William Radde and Emil Sauer, from whom any additional information may be obtained. Some of the pipe is in use in the store of Mr. Radde, 550 Pearl street, near Broadway."

A New Gas Company.—The Laclede Gas Company purchased yesterday, through the real estate firm of Conn & McRee, about nine acres of ground as a site for its works, located between Harrison and Dock streets, and running through from Second street to the river. The amount paid for the ground was $36,000 cash. An engineer has been engaged, and work will commence immediately. The fact of the purchase is of itself significant.—*St. Louis Republican, Jan.* 19.

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ARCHITECT AND GENERAL GAS ENGINEER,

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CHARLES MOWTON, Engineer New York Gas-Light Company, N. Y.
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AN ESTABLISHED FACT.

That the Gas Screens manufactured of Oak and interlaced Rattan, will allow the *same quantity* of Lime to purify *one hundred per cent more* Coal Gas than any other Gas Screen yet invented.

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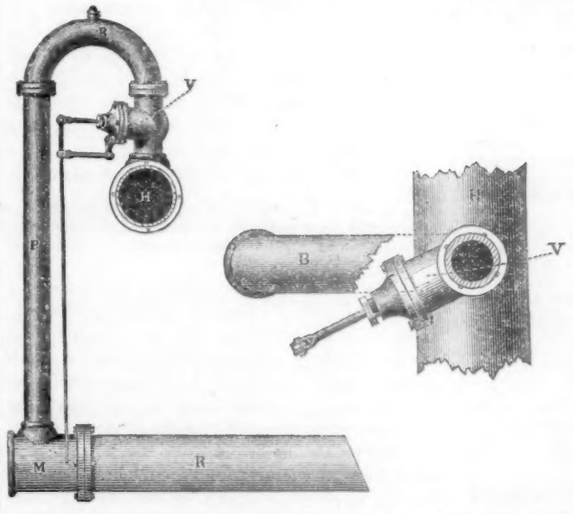

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☞ All communications to be addressed to "THE EDITOR, No. 42 Pine Street, Room 18, New York.

FRIDAY, FEBRUARY 2, 1872.

WISHING TO MAKE THIS JOURNAL an organ of intelligent discussion to those of our readers who may wish to gain or give information on the subjects to which its columns are devoted, the publishers solicit letters from all among them who make the study of these subjects a pleasure, or a profession.

Subscribers would confer a favor upon us by remitting *CHECKS*, or *POST OFFICE MONEY ORDERS*, as we are frequent losers where money is enclosed in letters.

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THE SCIENCE OF GAS-PURIFICATION.

In this number we conclude the long and quite valuable communication made to the North British Association of Gas Managers last June, by Mr. Innes, of the Forfar Gas Works, Scotland. This appears to us the best and most thorough discussion of the subject, from a point of view both chemical and practical, that we have had of late years. It merits the most careful reading, and we find in it several chemical points put in a light which is, to us at least, somewhat novel as well as instructive. To these we can give but scant space, and can in fact only run over a very few of them very hastily.

The fact that "no sulphide of ammonium is found in the liquor of the hydraulic main when tested with a lead salt" is very suggestive. It is stated that even in the condensers the ammoniacal compounds condensed are chiefly carbonate and sulphocyanide, the more volatile sulphide passing on to the purifiers. We have indeed always maintained the incorrectness of the loose statements so frequently met with in the books, that the crude gas after condensing, contains sulphuretted hydrogen. It is all *sulphide of ammonium*, which is quite a different thing, and which deposits as such in great measure, in lime-purifiers, combined, as a *sulphur salt*, with sulphide of calcium; some ammonia, however, passing on, set free by decomposition. When a fouled lime-purifier is opened the torrents of sulphide of ammonium vapor evolved, are due to the oxidation by the air of the sulphide of calcium, which sets free again the very volatile ammonium sulphide. Much error has been rife about all this. Mr. Innes himself is far from clear about it; as he says:

"As neither lime nor oxide of iron have any chemically-absorptive influence over ammonia, it is clear that, with the exception of what is mechanically suspended by these agents in the purifiers, this impurity, to a considerable extent, will pass into the gasholders and mains."

We wish we could say more on this ammonia head. Mr. Innes's remarks show close observation of the phenomena, but are very far from amounting to an exhaustion of the subject, which should receive from analysts far more special investigation. Its importance is very great, for example, in an *agricultural* point of view. Could we recover the ammonia from the 400,000 tons of gas coal used annually in New York and vicinity, we should gain, for the surrounding country, thousands of tons of one of the most potent of all fertilizers, sulphate of ammonia. This should concern us all, through our relations with the market gardens.

We learn from Mr. Innes, with regard to the *iron* preparations used for purification in Great Britain, the fact (peculiarly interesting to us), "that purifiers using oxide, require to have *a greater area* than lime purifiers." The contrast is such, presented here, with the results of our American method of iron purification (by the St. John and Cartwright mixture, of Staten Island ore and iron borings) by which this area is *greatly lessened*, that we would call very especial attention to it. Mr. Innes speaks with much admiration of the practical working of the plan (that commends itself so highly to the chemical mind) of using lime for removing carbonic acid alone, leaving sulphur for the iron to deal with.

We wish to call attention to what Mr. Innes says about the constant danger, in winter time, of clogging of the purifying mixture, and consequent blowing out of the gas through the seals and drips; in view of the late disastrous case in this city. In the case of the Metropolitan, we have been told that the agent used by them for purification was the "Laming mixture," of sawdust and copperas; and, moreover, that this very clogging caused the escape of the gas which exploded. This we give, however, only as matter of common report. We must be allowed to add, in passing, that many close observations of the working of St. John and Cartwright's iron mixture, have convinced us of the impossibility of any such cloggings taking place, as now practised under that system, without gross neglect at least.

THE MASSACHUSETTS GAS-INSPECTION.

[The following note was received from Mr. Stimpson, in time for the last issue, but was displaced by a press of other matters. We are sure that the regrets of our readers will follow this gentleman in his translation to his new sphere of usefulness. His original contributions to our columns have clearly indicated an unusual degree of adaptation for a specialty in which there certainly is in this country no overplus of experts possessed of real and thorough scientific culture. The late Massachusetts Inspector cannot, however, be deemed to deserve any censure for adopting a line of life in which his talents may find a wider field of expansion.—ED.]

OFFICE OF GAS INSPECTION,
11 Montgomery Place,
Boston, Dec. 27, 1872.

Professor Wurtz,
Editor of AMERICAN GAS-LIGHT JOURNAL.

Dear Sir: I have accepted the chair of Professor of Chemistry and Physics, in the University of Kansas, and C. W. Hinman has been appointed State Inspector of Gas and Meters for Massachusetts.

Please notice the change in your paper. Ask the publisher to mail my paper hereafter to my new address, and oblige

Yours truly,
FREDERICK E. STIMPSON,
Prof. Chemistry and Physics,
Lawrence, Kansas.

"FIRE PROOF" BUILDINGS.

In an item which has had an extensive circulation in the newspapers, purporting to convey some ideas of Hiram Powers, the sculptor, on the above subjects; he is represented as saying:

"The secret of fire proof building is this: It must be made impossible for the flames to pass through the floors or up the stairway. If you will have wood floors and stairs, lay a flooring of the thinnest sheet iron over the joists, and your wood upon that; and sheath the stairs with the same material. A floor will not burn without a supply of air under it. Throw a dry board upon a perfectly flat pavement and kindle it as it lies, if you can. You may make a fire upon it and in time consume it, but it will require a long time. Prevent drafts (*sic*, in our copy), and though there will still be fires no house will be consumed. The combustion will go on so slowly that discovery is certain in time to prevent any great calamity."

This appears to *verge on* common sense. It is very certain that our time-honored plan of building dwelling-houses, with walls and partitions of lath and plaster, seems but a wonderfully ingenious device for the propitiation of the fire-devil. The interspaces simply furnish so many combustible flues, almost equivalent to trains of gunpowder, for the fire to rush through from floor to floor; and wooden staircases have their undeniable share in promoting the joyous work of the fiend, and in realizing Coleridge's picture:

"I triumphed o'er the setting sun!
And all the while my work was done,
I, as I strode, with my huge strides,
Flung back my head and held my sides,
It was so rare a piece of fun ——"

It is our fear, however, that those who should repose confidence in the practical advice of Mr. Powers, sound as his fundamental ideas clearly are; might be very sadly enlightened when the dreaded contingency came. That a thin exter-

nal covering of sheet iron (or, we may add, even the coatings of soluble glass proposed by others) would be efficient in resisting for any important period, flames of the fierceness it would be liable to, will meet with no credit from those who have a familiarity with fire. Such sheets of iron are often ripped off and shrivelled up almost as pasteboard would be. Other conclusive objections (such as the rapid destructive action of iron on wood in our climate) we shall not dwell upon.

It will be ultimately found that the plan *we* have so frequently urged in these columns, that all houses and vehicles should be constructed altogether of wood impregnated *throughout* with fire-resisting deliquescent chlorides, is the only practicable and efficient means of baffling this diabolical enemy. Coating with soluble glass will be in many cases a useful subsidiary device. Though amazed at the total neglect with which our frequent presentations of this subject have been received, we still feel impelled by duty and humanity to harp thereon; and neither contempt nor even ridicule, much less indifference, will drive us from the field.

THE COOMBS IMPROVEMENT.

In regard to this new plan of keeping a standpipe free from obstruction, by means of a current of cold water flowing through a jacket, which was figured in our issue of December 2nd, we have several communications, which will receive further attention when we have more room. The secretary of the Youngstown (Ohio) Gas Company, Mr. George Cornell, writes that during the week ending December 16th, there were used 26 tons 1650 lbs. of coal from Wilson, Lee & Co., Rock Point, Beaver County, Penn., and made 234,500 feet of gas with six retorts, working about 20 hours per day, which is at the rate, for 24 hours, of 39,200 feet, or 6,533 feet per retort. The yield was 4.37 feet of gas from each pound of coal, of 17.5 candles power.

We will also take this occasion to add that in our note of January 2, on the editorial page, a mistake was made in supposing that the ton is reckoned in that section (as by us here) at 2240 lbs. We are now informed that they use the "short" ton of 2000 lbs.; and the yield we stated there, of but 3.92 feet per lb. of coal, becomes therefore, when rightly calculated, almost the same as the above, 4.38.

HEARTH AND HOME.—The publishers of *Hearth and Home*, in addition to the usual variety of that paper, have engaged a corps of first-class writers, who furnish to this journal the best *original stories*, of the *purest character* and *highest grade*—thus conveying much instruction in a pleasing form. Besides these, the *Hearth and Home* contains a large amount of first-class reading, editorials, literature, art, science, amusement; instruction for the housekeeper, the gardener, the farmer; a capital department for children and youth; the news of the day; financial and market reports, etc. Its engravings, costing over $25,000 a year, are of a high order of merit, unsurpassed by any illustrated paper in the world. Altogether, it is such a journal as may be safely and very profitably taken into any family. It is supplied at the low rate of $3 a year; four copies for $11; and ten or more copies for $2.50 each. Orange Judd & Co., publishers, 245 Broadway, New York city.

Important to Every Gas Consumer in New York.

READ THE TESTIMONY—NEW YORK TO BE THE BEST LIGHTED CITY IN THE WORLD.

TO THE NEW YORK HERALD:

For some time past a story has been industriously circulated in this city and elsewhere, that the MEMPHIS GAS-LIGHT COMPANY, of Memphis, Tenn., had abandoned the use of Naphtha Gas, and returned to the exclusive use of Coal Gas.

As this story, like many other stories of similar character, is put in circulation for the purpose of injuring THE MUTUAL GAS-LIGHT COMPANY of New York, and deterring citizens from becoming patrons of that company, I hand you a copy of the *Memphis Daily Appeal*, of date December 26, 1871, and beg that you will copy and invite the attention of your readers to two articles therein contained. They are a complete and crushing refutation of the malicious misrepresentations made with regard to the use of Naphtha Gas at Memphis. I would beg leave to call your attention to the fact that the Memphis Gas-Light Company have been using the Naphtha Gas, under the Gale and Rand patents, for over twelve months, and it is a source of pride and gratification to all parties interested in the Mutual Company, to be able to present to the public such conclusive proofs of the inestimable value of Naphtha Gas, as those contained in the statements of the officers and Board of Directors of the Memphis Gas-Light Company—a company having it in daily use for over a year.

The recent explosion in the works of the Metropolitan Gas-Light Company of this city, naturally induces the inquiry among those who desire to change their patronage from the old companies to the "Mutual," as to the relative danger of the two processes—"Coal" and "Naphtha." The best answer to this question is given by H. H. Edgerton, Esq., one of the most eminent gas chemists in the United States. In a report made by him to the Fort Wayne Gas-Light Company, he says:

"The relative danger of the two processes is only named because the Naphtha process has been denounced by a certain set of simples as extremely and inherently dangerous. All practical gas engineers are well acquainted with the source and causes of most accidents in coal gas works. They arise most frequently through disproportion or complexity of apparatus, combined with inattention and stupidity of workmen. It may be taken as an axiom that for every syphon, goose-neck, drip, tar-pipe or seal rendered necessary, an additional, though slight, element of danger is introduced. It would seem that a process which essentially decreased the number of seals, drips, etc., would to that extent decrease the danger. The purifying room and its care has always been considered as requiring considerable caution. The Naphtha Gas process dispenses with two out of three drips, goose-necks and tar drains, and also with a purifying house, and it is to be hoped that it will dispense with that endless amount of 'gab' about bisulphide of carbon, for the removal of which processes have been imagined that would equal in cost a naphtha gas works."

In the *Scientific American* of December 16, 1871, appears an article, said to be from the pen of the learned and famous chemist, Prof. R. Ogden Doremus, in reply to a communication which appeared in your paper on the 4th of December, with regard to "the terrible explosive qualities of Naphtha Gas." The writer says: "All of this terribly sensation statement is pure, unmitigated bosh, having no more foundation in fact than the stories of Munchausen or Gulliver. It is calculated to frighten those ignorant of the subject, and to injure the Mutual Gas-Light Company." Again: "A gas that will give a light from any ordinary-sized burner sufficient to read by is never explosive. The Mutual Gas-Light Company propose to furnish illuminating gas, and if they do this they will furnish a material as safe as any ever employed for lighting."

The Mutual Gas-Light Company not only intend to furnish the citizens of New York with illuminating gas, but of a quality and standard at least seventy-five per cent. better than was ever furnished by any coal gas company in the world, and better than any gas company can furnish by any known process other than the Gale and Rand. I predict that New Yorkers will boast within a year that New York is the best lighted city in the world, and consumers will bless the Mutual Company for breaking up the old gas monopolies on Manhattan Island, as well as for supplying them with the purest and most powerful illuminating gas ever seen by mortal eye. J.

[From the *Memphis Daily Appeal*, Dec. 25, 1871.]

TO GAS CONSUMERS.

The idea has gone abroad that the Memphis Gas-Light Company was ready to abandon what is termed the Naphtha process in the manufacture of gas. There never was a greater fallacy.

When we consider the material used—the essential oil of petroleum, scarcely merchantable for any other use; the richness of the gas produced, requiring, when used as naphtha gas alone, to be diluted with 42 per cent of air to reduce it to something like the standard of gas (measured by candle power) of the finest English cannel coal, the rapidity, certainty, and, under proper circumstances, the economy with which it can be produced, its use must be regarded as an advanced movement in gas manufacture, which should receive the attention of both practical and scientific men.

We have found it best to use this process in conjunction with the manufacture of coal gas. First, because we have a market for the residual products, coke and tar, at fair prices. Second, because our works and apparatus were constructed for the distillation of bituminous coals.

The late complaints about the quality of gas supplied to the city grew out of the fact that on account of the stock of naphtha running short and some changes being made at the works, the gas in the holders for a few nights was nearly pure coal gas, quite equal to the standard formerly produced by this company. The change from the use of naphtha was as perceivable and marked as if the burners had undergone a partial eclipse, and complaints as natural as if one accustomed to glasses had attempted to lay them aside suddenly.

By a slight change made in the connections with our naphtha gas meter, we can with ease inject such a quantity of this rich, inodorous and disinfectant gas into the holders as to immediately overcome any objections as to the quality of the gas throughout the city, not only raising the illuminating power to any given standard, but absorbing to a great extent the trace of sulphuretted hydrogen, which always imparts a bad odor to the best coal gas.

This we do not claim as a discovery, but the experimental test of the use of pure naphtha was most interesting and satisfactory.

On the evening of the 26th, about four o'clock, we had succeeded in getting ready for trying the effect on a large scale, of what is known in chemistry as gaseous diffusion, without regard to specific gravity. Not the uniform intermingling of gases, for that was a known scientific fact, but the time required for a complete mixture of gases through the mains (of extended) twenty-eight miles in length.

The holders contained about 170,000 feet of gas, with a make of about 15,000 to 18,000 feet per hour, when we commenced turning in the pure naphtha gas (running only two benches of threes) and making at the rate of about 8000 cubic feet per hour. The photometer (Sugg's make, London) measured the coal gas then in the mains at 14 candle power.

As soon as we observed from the test lights the naphtha gas was filling the pipes, we noted the candle power of the gas in the street mains to begin rapidly and steadily to ascend, and in twenty minutes more we found it was 18 candle power.

Going immediately to the office, in the heart of the city, to note the effect there, we found every one inquiring what had occurred, and surprised at the increased brilliancy of the light.

Thus in twenty minutes the illuminating standard of coal gas, 14 candle power, was raised to 18.

By no other process known to modern science and practice can such results be produced so rapidly. In the ordinary manufacture of coal gas complaints as to quality can only be remedied by a gradual process, which generally comes too late to meet complaints.

By this method alone is the effect immediate.

We can, therefore, assure the public that hereafter any just complaints as to the illuminating quality of the gas furnished the city can and shall be remedied promptly—not in one locality only, but throughout the extent of our mains. It must be understood, however, we cannot and do not undertake to make gas flow through pipes filled with scale or rust.

JAS. M. WILLIAMSON,
President Gas-Light Company.

GAS.

A CARD FROM THE MEMPHIS GAS-LIGHT COMPANY.

TO THE PUBLIC:

The Board of Directors of the Memphis Gas-Light Company desire to declare, in an authoritative manner, the future policy of their company, in regard to the sale of gas:

Our company is possessed of the most complete and ample appurtenances necessary for the manufacture and distribution of an adequate supply of illuminating gas for the city of Memphis, the right to vend which we claim as an exclusive and vested right. In addition to the extensive works for the manufacture of coal gas, we have in operation apparatus for manufacturing gas from naphtha, under the process secured by the Rand and Gale patents. By this method (owned and controlled entirely by us) an illuminating gas is manufactured by our company, superior to that which any other company can manufacture in this city, by from 50 to 100 per cent. This is a fact which will become patent to every gas consumer of the city, should another company enter into competition with us. Within the present week an improvement has been made at our works, which will for ever secure to this city the credit of possessing a light unsurpassed throughout the globe. Through the same agency we will hereafter be able to correct in a few minutes, deficiences in the power of the light we furnish, occasioned by cold weather, or from other causes.

We do not propose to lose a consumer on account of price. Should another company commence to sell gas at a price lower than the rate fixed by this company, we will at once reduce our rate to a point fifty cents per thousand cubic feet lower than the amount fixed upon by such other company, and will keep descending in the same ratio.

We would remind the public that we desire no assurances or guarantees on the part of our consumers, as we believe that whenever matters come to open competition, the superiority of the light offered by this company, to say nothing of inducements in price, will secure a continuance of the patronage it has so long enjoyed.

It is made the imperative duty of every officer and employee of this company to pay strict attention to the wants and requirements of our patrons, and any lack of courtesy or neglect of complaints, will subject the offender to severe rebuke, or prompt dismissal from our service.

Adopted by the Board and ordered published, December 28, 1871. JAMES M. WILLIAMSON, President.
GEORGE W. GIFT, Secretary.

OHIO GAS CANNEL, From the Sterling Colliery.

I am now prepared to place in the market, through my agencies as below, a regular and unlimited supply of this valuable Cannel, for gas purposes. A recent analysis, by Prof. WURTZ, Editor of this Journal, at the Laboratories of the NEW YORK GAS-LIGHT COMPANY, gave 47½ per cent of Volatile Matter and 45 bushels to the ton of a fair quality of coke. The yield of gas was at the rate of 9,500 feet per ton of about 27 candle power. It is not highly sulphurous, can be purified by Lime, and the ash from the coke does not clinker.

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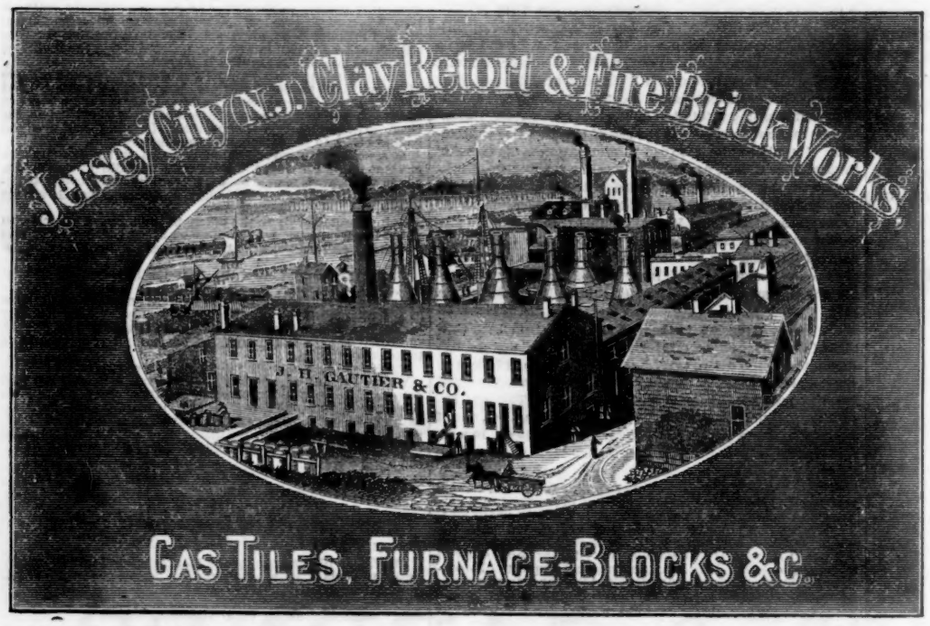

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WOOSTER, OHIO
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J. W. GRAHAM,

Dear Sir: Yours of the 14th inst at hand. In reply I would say that we have tested the six anti-freezing Lamp Posts purchased from you, and find them to be all as you represented. Whilst nearly a dozen of our sixty-five Posts were frozen down last month and first of this not one of yours was affected by the heavy frost. What can you sell them at?

Yours truly,
LUCAS FLATTERY
Sec'y Wooster Gas-Light Co.

Address the Patentee,
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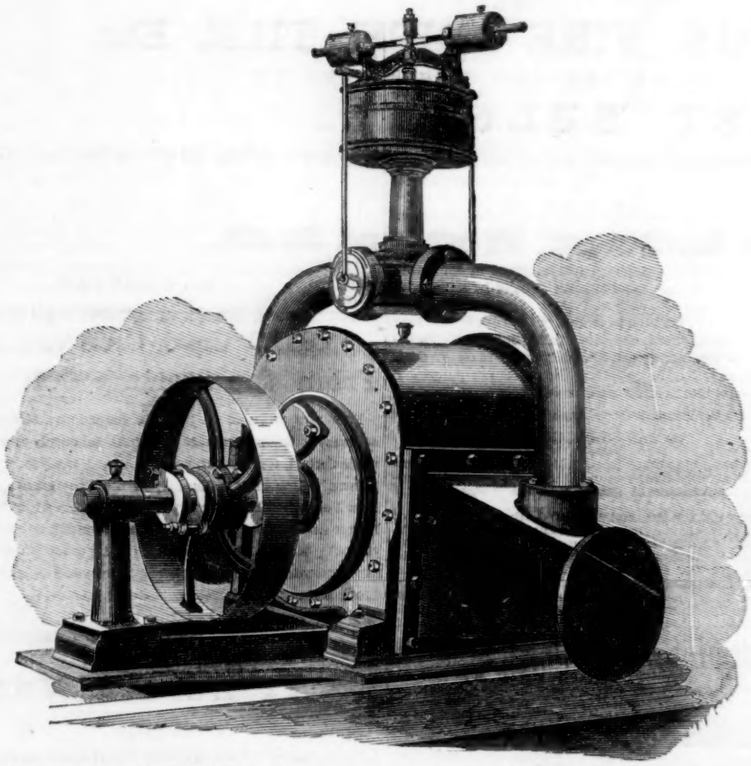

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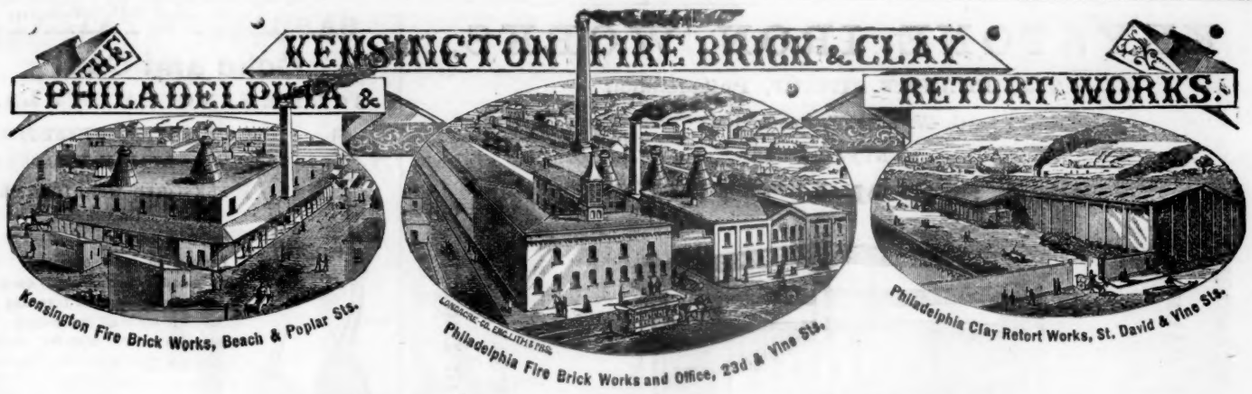
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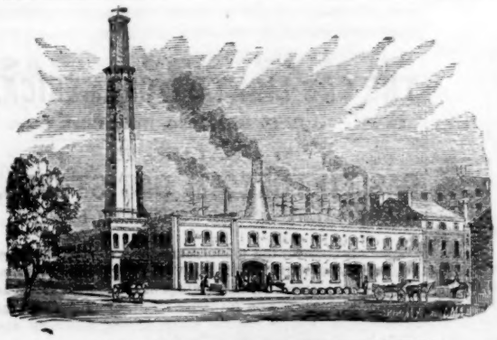

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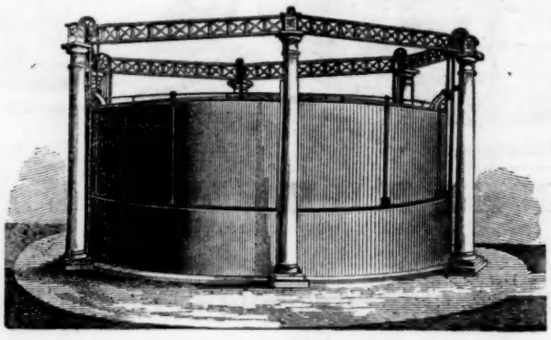

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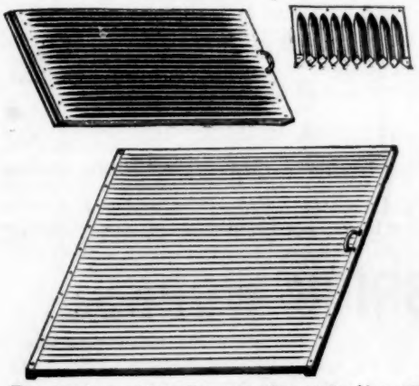

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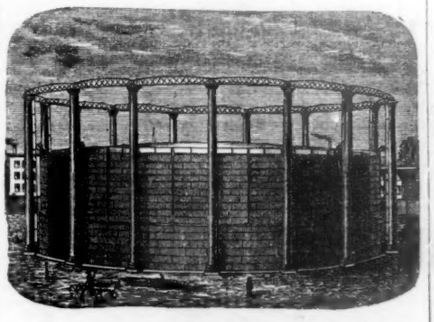

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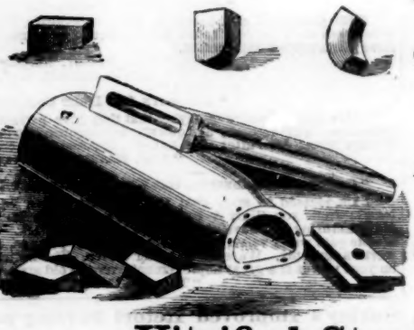

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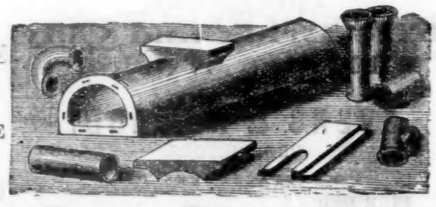

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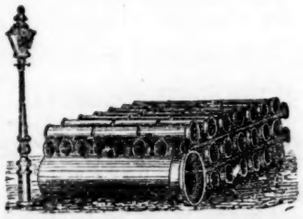

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PIG IRON & CAST IRON GAS & WATER PIPES.

Also, Heay and Light Castings of every description.
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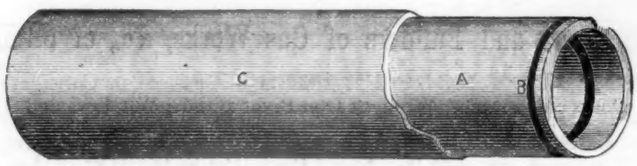

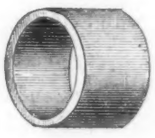

FIG. 2.

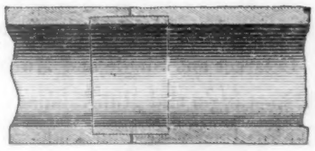

FIG. 3.

A—Cylinder of Wood. **B**—Band of Iron. **C**—Coating of Hydraulic or Asphaltum Cement.

FIG. 2.—Thimble for Connection. FIG. 3.—Horizontal Section and Connection.

Above is a cut of the

"WYCKOFF PATENT IMPERISHABLE GAS PIPE,"

manufactured by the NORTHWESTERN GAS AND WATER PIPE COMPANY.

This Pipe is made of White Pine, one inch to sixteen inches bore, in sections eight feet long, rounded in a lathe, coated inside and out with Asphaltum, connected with a tenon, or socket, and a thimble joint, perfectly air and water tight, being driven together with cement furnished by the Company. When laid its cost is about one half that of Iron Pipe, and is UNQUESTIONABLY the best Gas conducting Main in use.

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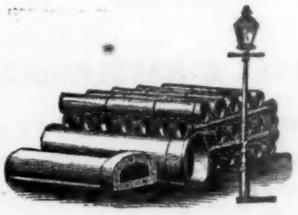

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2 inch Pipes in 8 feet lengths. 3 inch to 60 inch cast in 12 feet lengths.

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And every description of work necessary for Gas or Water Companies.

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STOP VALVES, from 3 to 30 inches, for both Water and Gas.

WROUGHT IRON WORK.

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Best quality American Charcoal Iron Boiler Tubes. Wrought Iron Tubes from one-eighth of an inch to ten inches diam., with all kinds of Fittings, Valves and Cocks, Gas and Steam Fitters' Tools, and all articles connected with the manufacture of Gas, Steam or Water.

Sole Manufacturers of P. Munzinger's Patent Purifiers, Dry Center Seals, Adjustable Hydraulic Main Stand, Wooden Lime Trays, Stand and Straddle Pipes, and Multitubular Water Condenser.

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